Competitive State-of-the-Art Structural Engineering

Design and Manufacturing of Steel Bridges in the Alaskan Arctic

Report INE/AUTC 17.10

By

Dylan Baffrey, Student
Elliott Anderson, Student
Kathryn Estas, Student
University of Alaska Fairbanks

for
Pacific Northwest Transportation Consortium (PacTrans)
USDOT University Transportation Center for Federal Region 10
University of Washington
More Hall 112, Box 352700
Seattle, WA 98195-2700

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16. Abstract

The University of Alaska Fairbanks College of Engineering and Mines has a legacy with the Steel Bridge Competition. Each year, since starting 24 years ago, the university has pushed the limits of the competition through vigorous ingenuity and teamwork. Having a small team, where funding is hard to come by and manufacturing is all done in-house, the team would seem to be at a disadvantage. However, the team has used their obstacles as challenges to overcome rather than to deter them. Through various community outreach activities, volunteering, and professional networking the Steel Bridge team gets involved with Fairbanks and raises enough funds for materials and travel to the Pacific Northwest and then onto National Conferences. Through in-house fabrication, the Steel Bridge Team learns hands on welding and design testing, and the value of transparency between design and construction. The team also focuses on building itself, developing the people around them into better, well-rounded, well-spoken and hardworking engineers of Alaska's future.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic	m^3
	meters NOTE: volumes greater than 1000 L shall be			
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inc h	lbf/in^2

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Acknowledgments

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American Society of Civil Engineers (ASCE)
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Abstract

The University of Alaska Fairbanks College of Engineering and Mines has a legacy with the Steel Bridge Competition. Each year, since starting nearly three decades ago, the university has pushed the limits of the competition through vigorous ingenuity and teamwork. Having a small team, where funding is hard to come by and manufacturing is all done in-house, the team would seem to be at a disadvantage. However, the team has used their obstacles as challenges to overcome rather than to deter them. Through various community outreach activities, volunteering, and professional networking the Steel Bridge team gets involved with Fairbanks and raises enough funds for materials and travel to the Pacific Northwest and then onto National Conferences. Through in-house fabrication, the Steel Bridge Team learns hands on welding and design testing, and the value of transparency between design and construction. The team also focuses on building itself, developing the people around them into better, well-rounded, well-spoken and hardworking engineers of Alaska's future.

Executive Summary

The annual Steel Bridge competition was created over two decades ago to foster excellence and ingenuity between civil engineering undergraduate and graduate students across the nation. The steel bridge competition is one of many great opportunities to get involved in extracurricular activities associated with the civil engineering field. The University of Alaska Fairbanks (UAF) has a long history of strong performance. We are nationally known for placing well in both the regional and national competition. Students design and manufacture 1/10 scale bridges with which they compete in a regional competition and if successful a national competition. The Pacific Northwest (PNW) Regional conference is usually held mid-April each year. Much preparation and work led up to this high point of the year. The steel bridge competition teaches students valuable skills that few other engineers have the chance or ability to learn, making steel bridge team members extremely valuable employees to their future employers. Together, students tackle and overcome tremendously technical work under conditions such as extreme sleep deprivation and strenuous class loads. As a team we overcame severe financial trials, technical challenges, and tight deadlines. The 2017 competition was held at the Boise State University in Boise, Idaho. The UAF Steel Bridge team swept the competition by first place overall and will compete for the national title on May 26th in Oregon. In addition to designing and building a steel bridge, members of the team also fulfilled hundreds of hours of community service and public speaking. They also support and comprise the core of the UAF Associated General Contractors (AGC) and the American Society of Civil Engineers (ASCE) student organizations. Steel bridge members sacrifice time with loved and dear ones as well as sleep and time allotted for homework in order to conquer one common goal; to design and manufacture the best bridge in the Pacific Northwest!!!

Chapter 1 Introduction

1.1 What is the Steel Bridge Competition?

The American Society of Civil Engineers, also known as ASCE, is a national organization committed to joining engineers and students. In 1987, ASCE began the very first steel bridge competition in Michigan, and within only a few years universities from across the nation were participating. Over the years, the rules encompassing the design have evolved as each year ASCE publishes a new design specification for that year's competition. New restrictions are added each year in order to instigate innovation within the students participating. In 2016, each state was represented at the National Steel Bridge Competition (totaling to approximately 250 universities), along with representation from seven different countries.

ASCE provides six different categories by which to judge the designs: efficiency, economy, stiffness, lightness, display, and construction speed. The competition is then broken up into several components: display judging, bridge construction, lateral load testing, weight of the bridge, and vertical load testing. All of these categories are summarized and considered and an overall score is given to each bridge. Based upon the scoring, a dollar value is given to each bridge, and the bridge with the lowest dollar value (that is the least expensive to construct in the real world) then wins the competition. The top three bridges from each region then advance to nationals.

According the ASCE's 2017 Rules, the bridge must not span more than 21 feet in length, and must not exceed 5 feet in height. This height restriction provides for schools to determine whether they feel as if an over truss or under truss design would best fit the specifications. Additionally, a vehicle clearance template is provided which must run along the entire length of the bridge unobstructed. This adds an entirely different component to the design of an upper truss, as the upper chord cannot extent directly vertically from the decking surface of the bridge. A minimum of 1.5 feet of clearance must run beneath the decking surface of the bridge, in between each footing. An alternate footing was provided in the 2017 specifications, to reduce the unsupported span length from approximately 21 feet to 17 feet. It was up to the designer to determine the exact placement of each footing, as long as they stayed within the 1-foot footing spaces allotted. The bridge must consist of members not exceeding the dimension box of 4"X6"X36", and be connected using connections following the provided specifications.

Any violation of these bridge dimensions would result in extreme penalties.

The 2017 University of Alaska Steel Bridge was designed to increase construction speed, reduce deflection, and minimize weight while meeting the dimensional envelope. The under truss configuration of the bridge was implemented to accelerate the bridge construction and minimize the weight of the overall bridge. By also integrating a cantilever into the design, the span length was reduced and the deflection was minimized. The angled truss running along the top chord reduced not only the vertical deflection but also the horizontal side-sway. In addition, a new connection design was integrated into a two-member deep deck truss to increase the construction speed while maintaining a large moment of inertia. The bridge was designed to have a flexible construction sequence that allows for placing either the upper or lower span of the bridge after the abutments have initially been placed.

1.2 Why Participate in the Steel Bridge Competition?

Participating in the Steel Bridge Competition provides students with not only the experience to design a bridge based upon their engineering understanding, but also with the opportunity to fabricate the design and see the entire process from start to finish. Because of this experience, engineering students involved in Steel Bridge are better rounded overall and are provided with additional opportunities upon graduation. Without this hands-on application of their theoretical engineering knowledge, students struggle to connect the dots between the classroom and the real world.

Steel bridge has allowed for me personally to find my overall purpose within engineering. Before becoming involved with the team, I struggled to apply the engineering theory I was being taught, and concluded that if the profession only involved theory and calculations, it would not be useful for me to utilize in the hands-on career I was pursuing. Upon joining the team, my view of engineering changed drastically. The motivation I was quickly losing returned as I was able to see the overall picture of design to fabrication to competition.

In addition to the expansive opportunity steel bridge provides for students' academic and personal development, it also provides the University of Alaska Fairbanks with the opportunity to compete with schools nationwide. Each year UAF thrives at both the regional and national ASCE Steel Bridge Competitions. In the years 2015, 2016, and 2016, UAF placed first overall for the Pacific Northwest Regional Competition, as well as placing first and second in the majority of the other categories. All three years UAF was invited to participate in the national competition, placing 9^{th} in 2015 and 6^{th} in 2016. We are looking upon our 2017 national’s invitation with great anticipation; as we are eager to compete see the placement of this year’s design.

Figure 1: The Steel Bridge Team Along the UAF Bridge During the 2017 ASCE Regional Competition

Chapter 2 Method

2.1 Recruiting Interest

Possibly one of largest challenges of the steel bridge competition is gathering a team that is willing to put in the time and dedication it takes to complete the project. This process is ongoing for the entire academic year. At the beginning of the fall semester the team from the previous year will present to the ASCE and AGC Student chapter, set up a booth at the engineering fair, and speak to several classes including (but not limited to): Introduction to Engineering, Statics, Dynamics, Mechanics of Materials, Structures, and Steel Design. Because gathering underclassman for the steel bridge competition is so essential to passing of the knowledge and building a competitive team, the steel bridge team will now be a part of the curriculum for the Introduction to Engineering class (ES 101). The arrangement the team has made with the ES 101 professor is to allow the steel bridge team to show the students the machine shop and previous bridge during their first lab for the civil engineering portion of the class. Not only will this effort to getting underclassman and new students involved early on help out with steel bridge, but it will also help the ASCE/AGC student chapter grow as a whole. Getting more students involved earlier on will also help with the local Ice Arch Competition, Concrete Canoe Competition, and volunteering outreaches.

2.2 Fundraising

Due to travel constraints, The University of Alaska Fairbanks overall competition budget is at least double that of most other schools. For example in order to bring a complete competition team, 10 tickets must be purchased at roughly $500 dollars apiece. Additionally, $800 for 2 vehicles is required for transportation around town. In addition, lodging for 4 nights with 3 rooms is approximately $130 a night for a total of $1,560. This total cost is roughly $7,500 excluding gas and other incidentals. On top of travel, the team also has to purchase supplies and steel in order to fabricate the bridge. This cost alone comes out to nearly $5,000. If everything goes according to plan, this all equates to the total cost to attend regionals of $12,500. After having just won the Pacific Northwest Competition, the budget has been approximately doubled due attending the upcoming National Competition.

2.3 Design and Analysis

The process for the design of the 2016-2017 Steel Bridge began as soon as the rules became available in mid-August. The first step in the design process is to carefully read, and re-read the set of rules. Due to ambiguity in the rules often times it takes consulting with the rest of the team or even advisors to truly determine what the rules are stating. In addition to consulting with teammates, the competition also provides a rules clarification blog, which is where schools and as questions about the rules to the nationals rules committee. The rules can best be described as a bid document for a real world river crossing where the site conditions and the desired bridge performance specifications are clearly outlined. The bridges are designed and manufactured to 1/10 scale according to the specified requirements of overall span (in order to cross the river), the required vehicle passage way and the required lane width (to make sure that vehicles and semi-trucks will be able to pass across the bridge), the largest possible member size order to be able to transport the pieces to the site based on local road restrictions and equipment assembling the bridge), and the approved types of connections. In addition, a large emphasis is put on accelerated bridge construction (ABC) in order to save money and time during manufacturing and assembly of the bridges on site. The rules generally start the same way by outlining a mission and summary:

> *"Civil Engineering students are challenged to an intercollegiate competition that supplements their education with a comprehensive, student-driven project experience from conception and design through fabrication, erection, and testing, culminating in a steel structure that meets client specifications and optimizes performance and economy. The Student Steel Bridge Competition increases awareness of real-world engineering issues such as spatial constraints, material properties, strength, serviceability, fabrication and erection processes, safety, aesthetics, project management, and cost. Success in competition requires application of engineering principles and theory, and effective teamwork. Future engineers are stimulated to innovate, practice professionalism, and use structural steel efficiently" … The Student Steel Bridge Competition provides design and management experience, opportunity to learn fabrication processes, and the excitement of networking with and competing against teams from other colleges and universities* (Student Steel Bridge Competition, 2017 Rules).

The 2017 (simulated) problem statement is based around an advertisement sign for the new subdivision, Beaver Lodge Estates:

> *"These signs will announce a new subdivision along the banks of the Luckiamute*

River. But first, even before the lots are platted, civil infrastructure will be in place. Water and sewer lines already run parallel to the river, and a design competition will culminate in a contract for a bridge. The Luckiamute is scenic and environmentally sensitive. Damage to the banks will be minimized by locating bridge foundations back from the river, by staging construction equipment and materials even farther back, and by limiting the weight of transported loads. Temporary piers are permitted. High water in spring requires clearance under the bridge, and cost is minimized by completing construction before that season. Deck, foundations, and approaches will not be included in the bridge contract. A site survey indicates that a simple span of approximately 200 feet would be feasible, but the foundation at one end would conflict with the existing water and sewer pipes. Therefore, the contract for this bridge design would include the cost of relocating these utilities. Alternatively, the foundation could be nearer the river, and the bridge would have a cantilever extension over the pipe location thus eliminating the relocation charge. Both alternatives, simple span and cantilever, have the same overall length. Serviceability, construction cost and duration, material cost, and esthetics are critical considerations. Steel is specified for ease of prefabrication, rapid erection, superior strength to weight ratio, durability, and high level of recycled content."

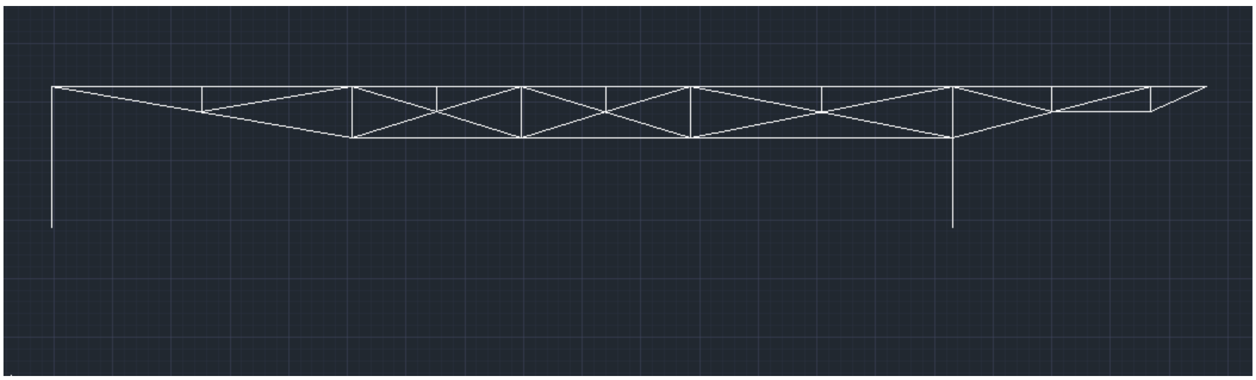
Based upon the given design statement, the team set out to design a 1:10 scale model, demonstrating the bridges concept. The bridge will be judged on multiple criteria including durability, constructability, usability, stiffness, construction speed, efficiency, economy, and attractiveness. Although there are several categories presented, the competition boils down to three categories, (stiffness, weight, and construction speed) which make up the two subcategories of construction economy and structural efficiency. The construction economy is calculated as follows:

Construction Economy = Total Time (minutes) x number of builders (persons) x 50,000 ($ per person-minute) + load test penalties ($). The *Structural Efficiency = Total Weight of the Bridge (pounds) x $10,000 ($/pound) + Aggregate Deflection (inches) x $1,000,000 ($/inch) + load test penalties ($).*

After the rules are read and the scoring is understood, the team begins the design process. Daniel Hjortstorp, a previous year's bridge captain once said, "It is easy to design a bridge that will be adequately strong, but it requires an exhausting amount of iterations to develop a competitive design."

During the design process the team primarily considers the weight and the stiffness of the bridge because it is extremely hard to determine how long the bridge will take to construct when it hasn't been built. To go about the designing the team starts with designing bridges in 2 dimensions using the software AutoCad. The reason the team starts in 2 dimensions is because it is much faster to analyze a bridge in 2 dimensions that it is in 3 dimensions. Due to the simplicity of AutoCad versus RISA, bridges are first drawing as lines in AutoCad. **Figure 2** shows an example of one of the tens of bridges drawn in order to determine the structural shape of the bridge.

Figure 2: 2D – Designing the Bridge



Once the bridge has been draw in AutoCad it is imported into the finite element software, RISA 2D. Once the bridge has been imported, all aspects of the structural parameters of the design can be looked at, this include but is not limited to: material properties, shapes, joint reactions, joint deflections, member forces, member stresses, and member deflections. **Figure 3** below displays an example of a 2D bridge in RISA 2D.

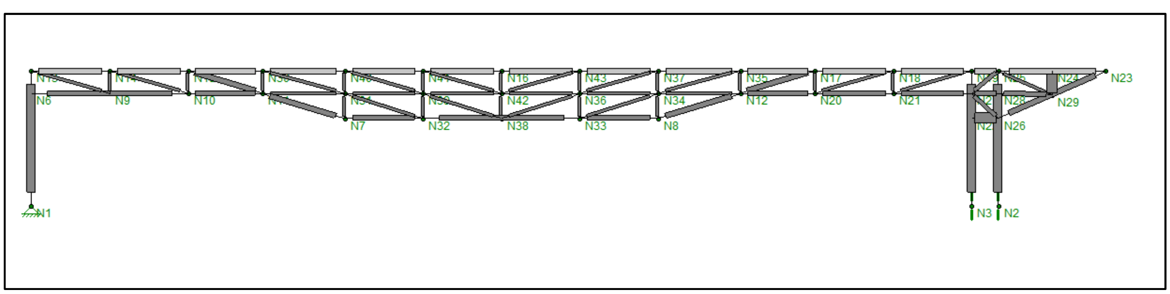


Figure 3: 2D RISA Model

Based upon the RISA model shown above and the parameters given from the analysis the best overall shape of the bridge can be determined. The main question to be determined by the design team is whether the bridge will be an over truss or under truss. In order to determine this both the load cases and the footing options need to be looked into. **Table 1** below shows the six different load cases, and **Figure 4** below shows the optional footings.

S	Wb (lb.)	Wc (lb.)	M
1	1900	600	5'-6"
2	1900	600	6'-6"
3	1900	600	8'-6"
4	1700	800	5'-6"
5	1700	800	6'-6"
6	1700	800	8'-6"

Table 1: Load Cases

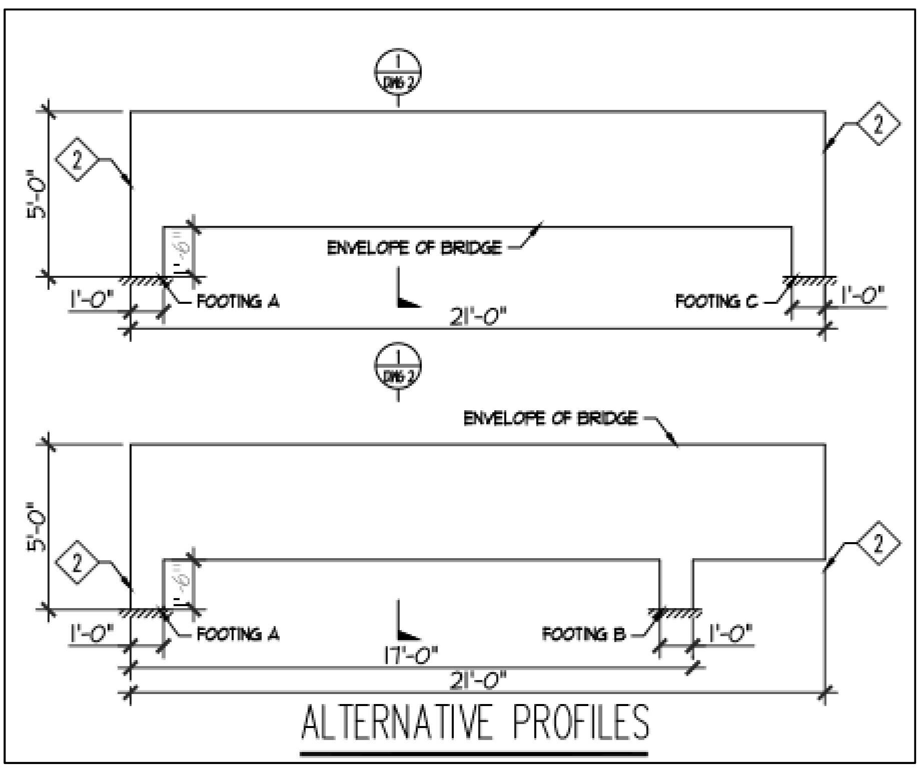


Figure 4: Optional Abutments

Figure 4 displays the optional abutments, most years the footings are only given as one option, but this year the rules had two options resulting in another decision when trying to determine the overall shape of the structure. This year the rules stated that either footing AB could be used, or footings AC, but if footing AC were used than a $150,000 penalty would be added to the overall score. This presented an addition challenge in itself because the loads of the bridge stayed in the same location for both footings. After several iterations and trials of this, the bridge design team narrowed down the design to the top five best 2D bridges. From this point the team drew the bridges in AutoCad again, but this time in 3 dimensions. Once again the team analyzed the bridge in RISA.

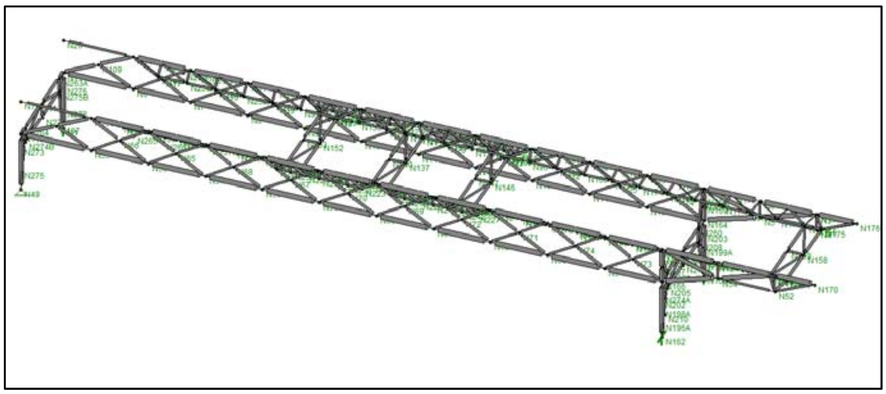


Figure 5: RISA 3D Model

After all 5 bridges had been analyzed the best design was chosen. This was done not only based upon score but also constructability. **Figure 5** shows final design in RISA 3D for the 2017 UAF steel bridge. Based on final design the team then ordered steel and started fabricating. Although the design of the bridge was done, the computer work was not. The bridge was once again imported back into AutoCad to create shop drawings for the fabrication team. An example of one of the several pieces of the bridge is displayed below in **Figure 6.**

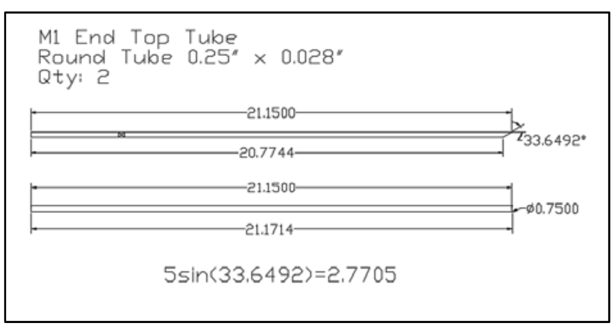


Figure 6: Shop Drawing

The shop drawing above communicates from the design team to the fabrication team on how to make the individual pieces of the bridge. As displayed in the figure, the name of the piece is shown, type of material, the quantity, length, angle, and radius. From this point on the fabrication team can start the fabrication process.

2.4 Bridge Manufacturing and Machining

Due to some schools lacking appropriate shop facilities and supervision, universities are not required to fabricate their own bridge. Teams are allowed to use services of a commercial fabricator is they develop the work orders and shop drawings, and observe operations. Although this is an option, the team strongly believes that one of the most beneficial phases of this project is fabricating our own bridge. This is the final step in the process where the team catches errors that were missed during the design process, in addition this is also the place where the team realizes what looks great in the computer is not always practical. The pieces don't always go together exactly as they are shown in the computer. This alone teaches students to be able to adapt and make changes on project.

Once steel arrives, the fabrication crew gets to work by cleaning all the steel. From there each piece of the bridge has to be milled to the precise length and angle (with a 1/1000" precision) requiring excellent skill and craftsmanship. **Figure 7** below displays a piece being cut to length in the milling machine.

Figure 7: Milling

The reason for the precision is to try and make the model that was analyzed in the computer most closely resemble the actual product. This alone takes hundreds of hours because it's not uncommon for a piece to have dozens of different steps in the manufacturing process. After all the pieces of the bridge are fabricated, jigs are made in order to weld the individual pieces into members. Once all the pieces and connections are welded, a member is considered complete. **Figure 8** below is an example of a connection that was used in the bridge, in addition **Figure 9** shows a completed member of the bridge.

Figure 8: Connection

Figure 9: Completed Member

Chapter 3 Results and Discussion

3.1 Competition Results

This year 2017 PNW Regional Steel Bridge Competition featured fourteen schools all competing to be the best overall bridge for the region and earn an invitation to nationals. After 2 days of competition, several schools stood victorious. Oregon State University took the third place with a calculated score of $7,530,000; University of British Colombia took second place with a total score of $6,430,000; and for the 3rd year in a row UAF won the overall first prize by a large margin with a total score of $4,213,333. In addition to the overall award UAF, placed quite well in the six sub categories. With a build time of 11:42 with 4 builders, we had the second quickest time and second best construction economy. An overall weight of 92lbm earned us first in lightness with second place award in stiffness both combining to give an overall first place award in structural efficiency. We also won fourth in display. While it would be desirable to clean house as in years past, structural limitations and scoring methods prevented this from being possible. UAF has a prestigious history of excellence at the regional competitions. To take both lightness and structural efficiency is an accomplishment in itself. It is incredibly difficult to construct a bridge that uses a minimal amount of material the most efficiently considering the differing scoring weights between the categories this season.

Figure 10: Regional Champions!

3.2 Lessons Learned

Out of all the engineering competitions available to engineering students, the Steel Bridge Competition leads in both the breadth and depth of lessons learned. Fortune may favor those who put forth the effort, but when combined with an effective team working for a common goal this effect is compounded. Together the steel bridge team has had to adapt and overcome many technical, academic, personal obstacles to successfully deliver a not only complete, but also competitive product in such a short period of time. As a group, we survived severe financial struggles, brutal academic schedules, and tight deadlines. We went above a beyond just designing and building a competitive steel bridge. This year we had several designated community service opportunities and have given back several hundred man-hours to the community. We have also been asked to speak and give lessons to elementary school kids about structural design and engineering in general. In many ways, the steel bridge team is the backbone of our AGC and ASCE student organizations. We are the go-to group for anything that requires manpower or leadership on short notice. This has led to the steel bridge team becoming some of the faces and poster children for UAF's Collage of Engineering and Mines. All of this because of one shard common goal; to design and manufacture the best bridge in the Pacific North West! We may have stated off trying to only achieve a common goal, but have managed to achieve far beyond our expectations. As we worked on bridge and improved our real world understanding of engineering we also gain important team work skills, a work-ethic incomparable to most traditional students, and a deep personal drive for excellence that will benefit us no matter what industry or project we're determined to see through. Though this experience everyone on the team has also managed to gain camaraderie and long term friendships that produce many opportunities otherwise inaccessible. When will power falters and goals seem distant there is always someone in the group who will provide encouragement and help renew focus to the task at hand.

In summary, some of the most important lessons learned are:

- Each task will take at least three times longer than expected.
- Planning, planning, and more planning is required to keep a project on track and successful.
- Build a team and the product will build itself.
- Have fun and maintain good morale even when things are tough.
- Never let a task on the critical path fall behind.
- Always have a backup plan.

3.3 Networking/Resume Building

The greatest aspect of steel bridge is not the competition itself. The networking and professional opportunities are second to none. The steel bridge competition creates unmatched camaraderie and lifetime friendships. These friendships extend beyond school and form a foundation of contacts throughout the state. Maintaining a competitive Steel Bridge Team requires a total annual budget of $50,000 for materials and travel. Because of this, students gain extremely valuable fundraising and budging experience. Over the course of the year students spend countless hours interacting with businesses, professionals, and organizations around the community. In order to raise the support necessary to ensure UAF's legacy of elite national performance and prosperity will continue for new and future UAF CEM students alike.

3.4 Community Involvement

In our continual efforts to build our product, we build a team and build a community. UAF prioritizes community involvement through various volunteering activities. AGC and ASCE organize several opportunities for students to be active including a 2015 event where students built bunk beds for homeless youths. UAF students also raised record amounts of canned food items to donate during a canned food drive on campus, giving additionally to the Fairbanks homeless. Other community outreach activities for UAF students include teaching homeschooled students about arches, building model bridges with students at a local elementary school, and constructing model wind turbines with 6th graders visiting UAF for a math day. The work UAF does with the community is priceless, and offers another layer of involvement for the team. Through these outreach events, the team gets to put their knowledge and skills to use in real-world applications.

Chapter 4 Conclusion and Recommendations

The UAF Steel Bridge program offer students a great opportunity to get involved into an extracurricular activity associated with the civil engineering field. Participation grants students with applicable skills, community networking, and hands-on experience in the field of Civil Engineering. UAF has a long history of strong performance at both the regional and national competitions; once again proven by the strong performance at the 2017 regional competition at Boise State University in Boise, Idaho. The UAF Steel Bridge team swept the competition by first overall. The success of the UAF steel bridge team should however not be measured by the trophies and titles won, but rather by the camaraderie and educational advantage that the members of the 2017 steel bridge team has acquired through unmatched teamwork and focus on a common goal.

In the words of my personal mentor, Daniel Hjortstorp:

The potential professional development and growth that lie ahead of each member of the elite UAF steel bridge brotherhood is endless. I am thrilled to see each one of these extraordinary engineers spread across the nation to make the United States and the world a better place through sound and innovative engineering. Meanwhile, I hope that the strength of the UAF Steel Bridge program will continue to grow through sustained alumni and community support so that future students can receive the same exceptional opportunities that we received. Teamwork lay at the base of the UAF Steel Bridge program. It is the transfer of knowledge between steel bridge generations that make us who we are… may the curiosity for learning and advancement never stagnate.

Thank you for a chance to explain the Steel Bridge Competition, and its effects on our growth as students, individuals, and innovators.

Elliott Anderson

Graduating Senior, B.S. Civil Engineering,

UAF 2017 Steel Bridge Designer and Team Captain

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Appendix A

I. Pictures

Figure 11: Welding

Figure 12: Bridge Assembly

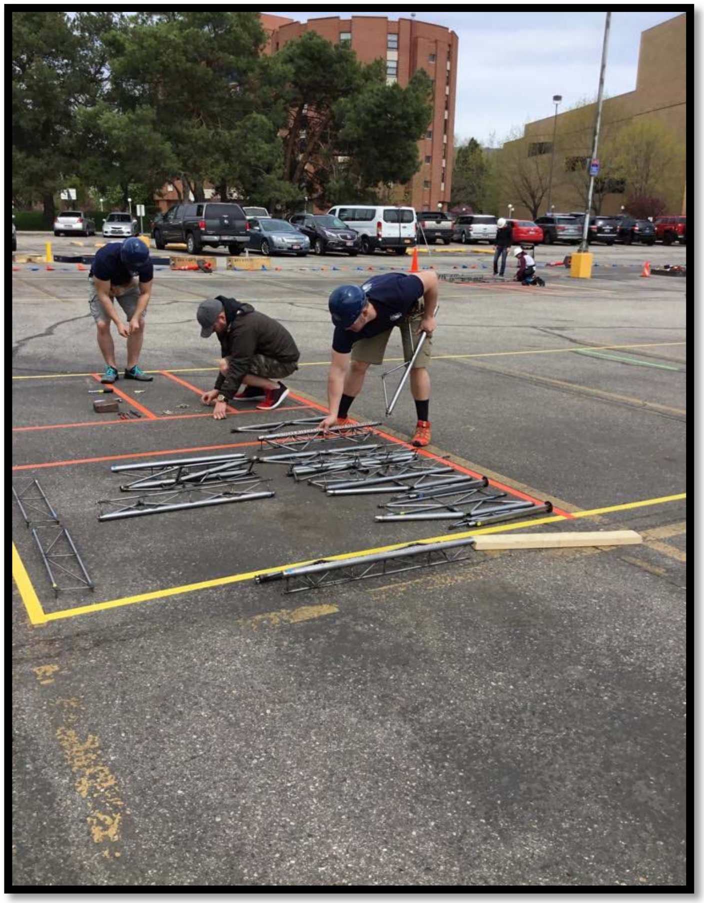


Figure 13: Setting Up Each Piece Before the Timed Assembly at the Competition

Figure 14: Final Product Display

Figure 15: Applying the Pound Load

Figure 16: Connections

Figure 17: Jig for Cutting Small 4130 Round Tube in the Mill on the Left. CNC'd Interrupted Threads on the Right

Figure 18: Team Photo with Bridge

Figure 19: Elementary School Outreach Group

Figure 20: Teaching Students How to Make Candy Bridges

Figure 21: Helping Homeschool Students Understand Arches

Figure 22: Building Wind Turbines with 6th Graders


ALL ENGINEERS
WELCOME!
Topic of Presentation:
Six Qualities of a Servant Leader
Presenter: Marc Luiken -
Commissioner for the Alaska Department of Transportation and Public Facilities
TUESDAY (4/25/17)
1:00 PM, Duckering 252
THE ASSOCIATED GENERAL CONTRACTORS OF AMERICA
AGC
ASCE
Posted: 4/24/17

Figure 23: Professional Development Amongst UAF Students

"ADDRESSING THE NEEDS OF OUR STUDENTS AND PLANTING THE SEEDS FOR SUCCESS"

2014 FALL SEMESTER NEWSLETTER

Shaping tomorrow's leader's

The AGC Student Chapter Members were a large contributor to this year's winning team of the UAF Starvation Gulch.

After creating scaled construction, logistics, and safety plans, the giant pile of pallets took shape well within the small 4-hour window of time allowed. The "twin tower bridge" design concept required students to become resourceful, to work creatively within the rules, and to collect *thousands* of pallets after classes and homework.

Using some basic academic skills, hands-on ability, and competitive spirit, this group of students brought pride to the chapter, learned some valuable skills, and had some fun in the process. Also, the project attracted several Freshmen, and helped to recruit new members.

The bonfires have been a symbol of the passing of the torch of knowledge to new students at UAF since 1923.

Top: Student Chapter members pose after completing the construction of a bonfire for Starvation Gulch. It was the only bonfire with a scaled drawing, and construction plan.

Bottom: Bonfire lights up the night, with the letters "UAF CEM" back-lit by flames.

Helping Those in Need

Members from the UAF AGC Student Club had the opportunity to give back to the community by building bunk beds for a relocated homeless family. Students volunteered their Halloween Weekend to build and deliver these beds to a family of six kids in great need.

AGC members helping to build bunk beds.

Figure 24: AGC Newsletter We Created to Gain Student and Community Interest

II. CAD Drawings

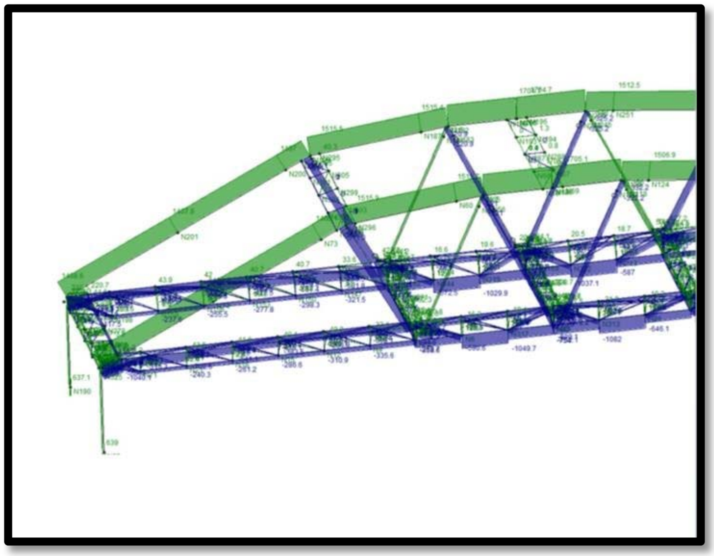


Figure 15: Axial Forces Traveling Through Members in Previous Year's Bridge Design

Figure 26: CAD Drawing of Male-Female Connections

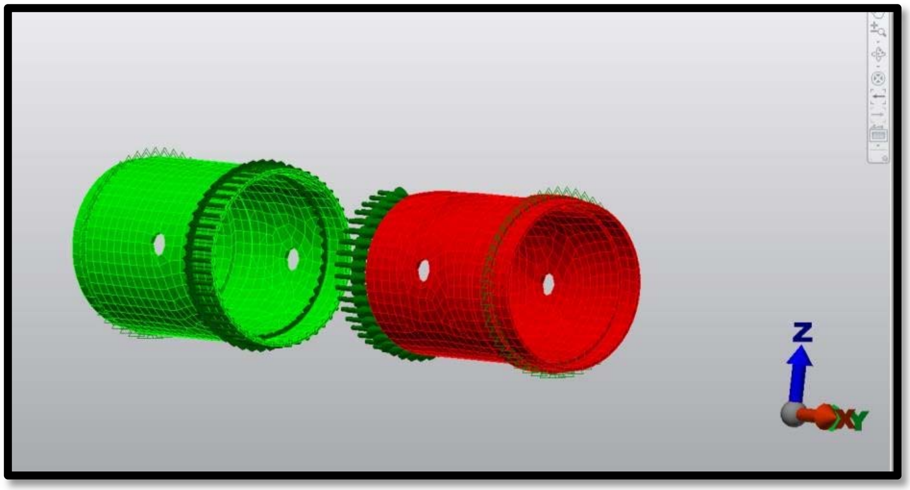


Figure 27: Analyzing Sleeve Connections with Autodesk Simulation

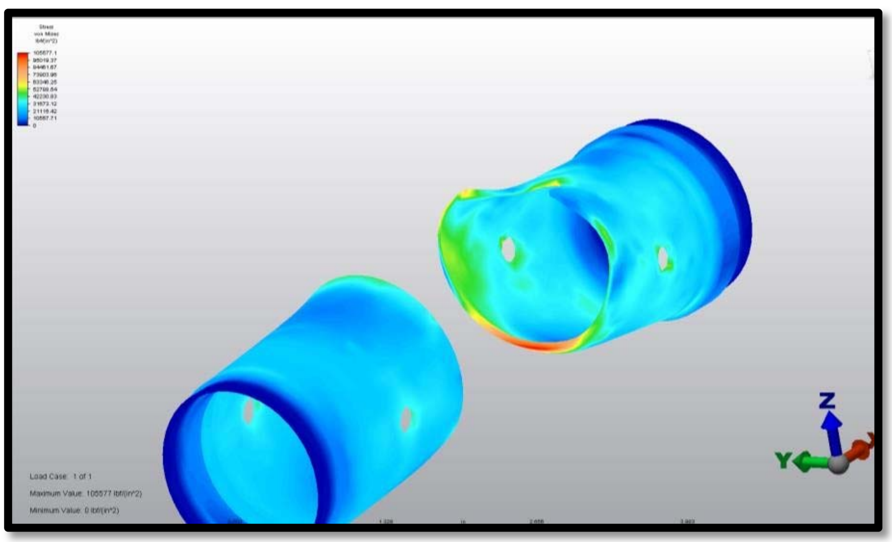


Figure 28: Analyzing Sleeve Connections with Autodesk Simulation

III. Fundraising Material

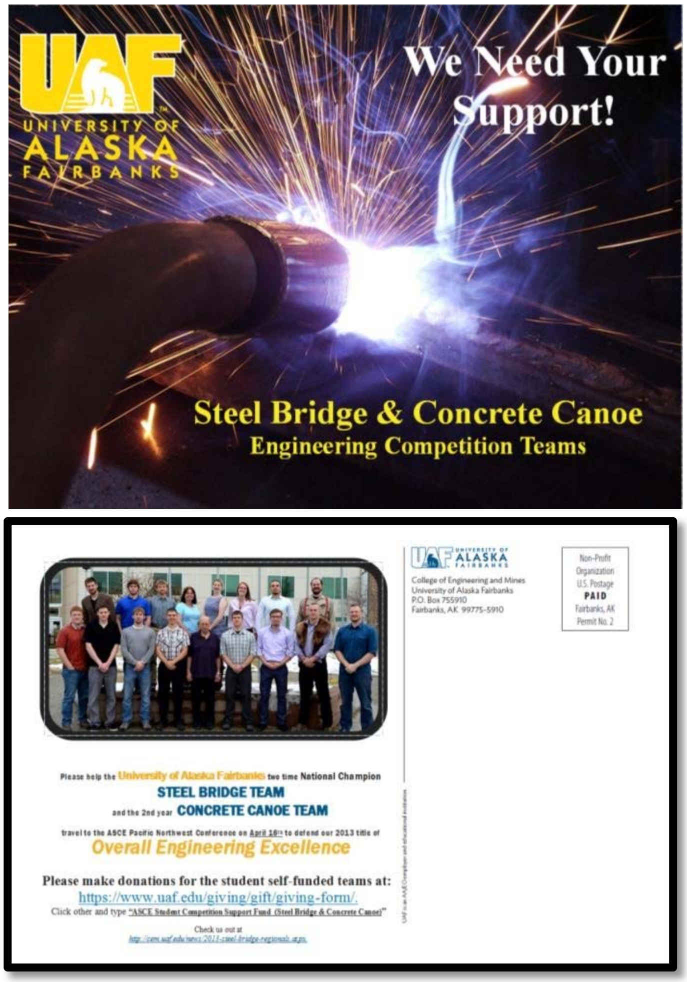
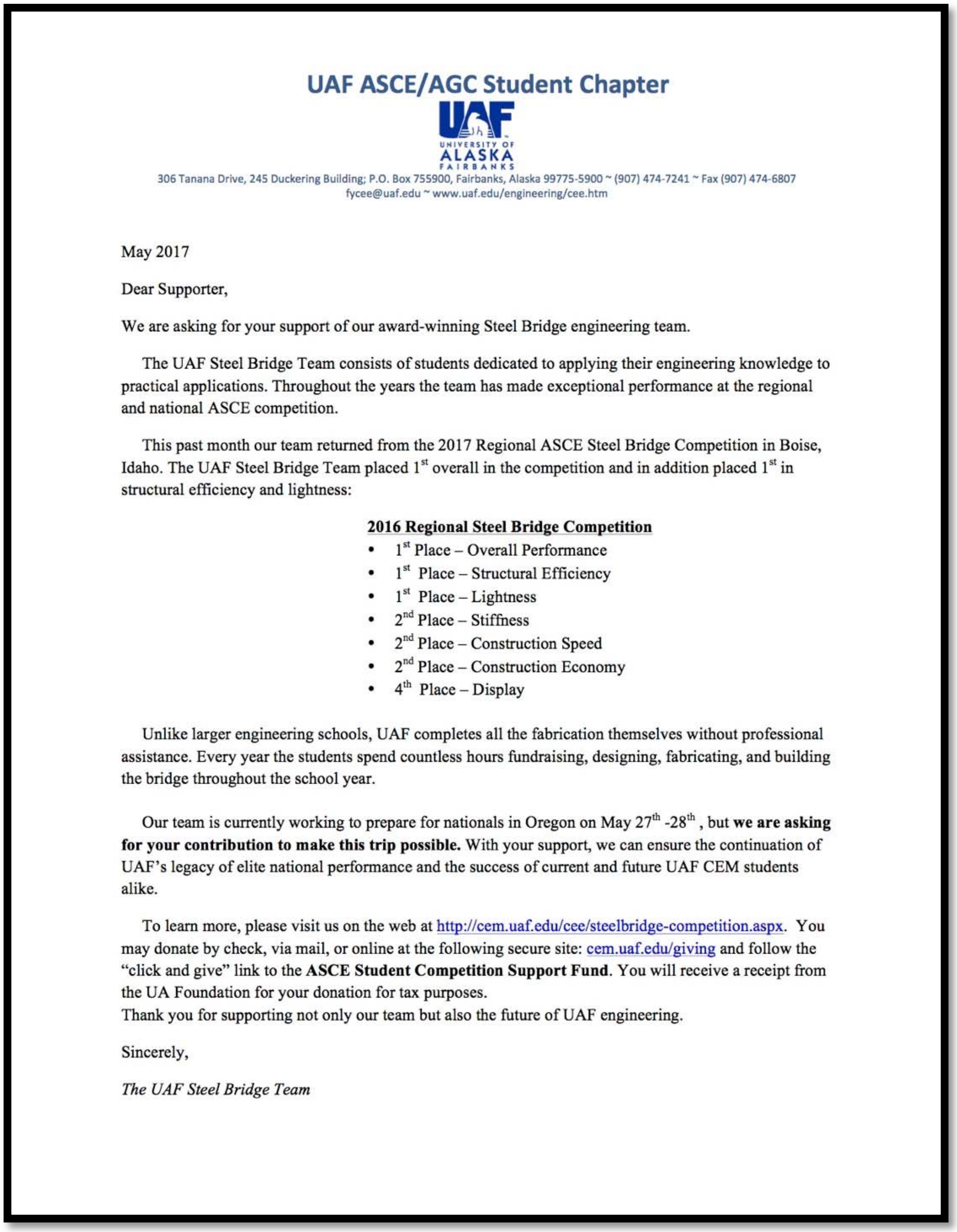


Figure 29: Fund Raising Post Card



UAF ASCE/AGC Student Chapter

UAF UNIVERSITY OF ALASKA FAIRBANKS

306 Tanana Drive, 245 Duckering Building; P.O. Box 755900, Fairbanks, Alaska 99775-5900 ~ (907) 474-7241 ~ Fax (907) 474-6807
fycee@uaf.edu ~ www.uaf.edu/engineering/cee.htm

May 2017

Dear Supporter,

We are asking for your support of our award-winning Steel Bridge engineering team.

The UAF Steel Bridge Team consists of students dedicated to applying their engineering knowledge to practical applications. Throughout the years the team has made exceptional performance at the regional and national ASCE competition.

This past month our team returned from the 2017 Regional ASCE Steel Bridge Competition in Boise, Idaho. The UAF Steel Bridge Team placed 1st overall in the competition and in addition placed 1st in structural efficiency and lightness:

2016 Regional Steel Bridge Competition

- 1st Place – Overall Performance
- 1st Place – Structural Efficiency
- 1st Place – Lightness
- 2nd Place – Stiffness
- 2nd Place – Construction Speed
- 2nd Place – Construction Economy
- 4th Place – Display

Unlike larger engineering schools, UAF completes all the fabrication themselves without professional assistance. Every year the students spend countless hours fundraising, designing, fabricating, and building the bridge throughout the school year.

Our team is currently working to prepare for nationals in Oregon on May 27th -28th , but **we are asking for your contribution to make this trip possible.** With your support, we can ensure the continuation of UAF's legacy of elite national performance and the success of current and future UAF CEM students alike.

To learn more, please visit us on the web at http://cem.uaf.edu/cee/steelbridge-competition.aspx. You may donate by check, via mail, or online at the following secure site: cem.uaf.edu/giving and follow the "click and give" link to the **ASCE Student Competition Support Fund**. You will receive a receipt from the UA Foundation for your donation for tax purposes.
Thank you for supporting not only our team but also the future of UAF engineering.

Sincerely,

The UAF Steel Bridge Team

Figure 30: Fund Raising Letter Nationals 2017

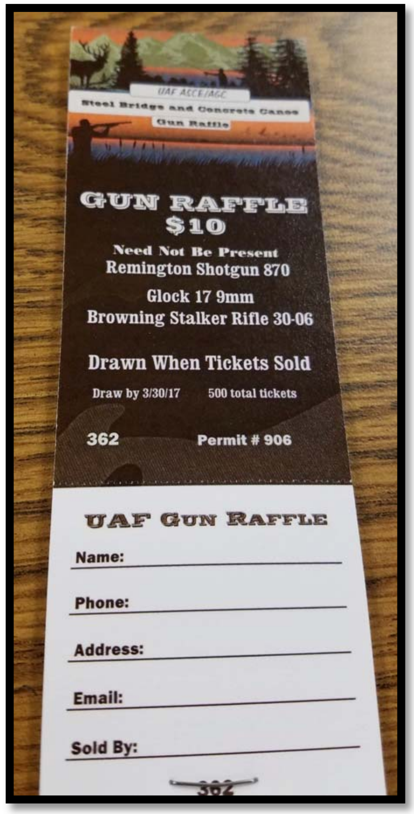


Figure 31: Gun Raffle Ticket